Homeland CBR Defense: Technical Challenges of the 87% Solution

Presenter: William Blewett

Battelle Edgewood Office

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The 87% Solution

To make buildings in which we live, work, and spend leisure time highly protective against airborne hazards

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The Goal

To make buildings highly protective against airborne hazards

at affordable cost

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The Covert Attack

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Strategies of CBR Defense

- *Prevention*
- *Protection*
  - *Air Filtration*
  - *Controlling Air Exchange*
- *Mitigation*

A Building as a Protective System

- *A building is a system of barriers, filters, and fans.*

- *Its protection against airborne hazards is governed by*
  - *The efficiency of filtration*
  - *The volume of unfiltered air exchange induced by fans, buoyancy, and wind.*

Buildings and their HVAC systems are not suited for high levels of protection

- *HVAC-system filters have low efficiency, high bypass.*
- *HVAC systems are configured to draw outside air.*
- *Typical building envelopes are not tight enough for pressurization with normal minimum volumes of outside air.*

For high levels of protection, pressurization is essential

You can switch fans on and off

You can't turn off the wind or buoyancy pressures.

Two approaches for applying air filtration

- ***External filtration*** *with pressurization (zero unfiltered air exchange) - high PFs*

- ***Internal filtration*** *(recirculated air) - low PFs because no control of unfiltered air exchange.*

What is the criterion for "highly protective"?

We have a protection-factor criterion for the battlefield.

It is 6,667, based on threshold effects of sarin and outdoor doses delivered by Soviet chemical weapons

We have no collective-protection criterion for homeland defense.

Based threat agent toxicity, it should be greater than 10,000.

What level of protection do buildings provide?

- *Buildings normally have little or no filtration for CBR agents and provide very low protection factors -- PF roughly 1 to 5*

- *There are very few highly protective buildings, and their protective systems are very expensive -- PF roughly 10,000 to 100,000.*

- *For transient hazards with forewarning, air-exchange rate control makes a building protective -- PF roughly 2 to 100*

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Controlling Air Exchange as a Protective Action

Sheltering in place requires a well-timed altering of the air-exchange rate -- twice:

- *Decreasing the building's air exchange rate before arrival of the plume.*
- *Increasing the air exchange rate immediately after passage of the plume.*

Without making these changes, a building provides no dose reduction

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Standoff Delivery of Toxic Industrial Chemicals

Release	Chemical	Quantity	Deaths
Bhopal, 1984	*MIC*	*40 tons*	*3,000*
Ypres, 1915	*Chlorine*	*160 tons**	*5,000*
10,000-gal tanker	*Chlorine*	*50 tons*	

**line source 4 miles wide*

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High-level protection against a terrorist attack requires

- ***Continuous, high-efficiency filtration***
- ***Pressurization***

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The cost of a highly protective system

Retrofit of Dormitory A (24,450 sq feet)

Cost of CP system installed: $1.3 million ($53/sq ft)

Leakage rate at 50 Pa = 0.18 cfm/sq ft

Retrofit of Dormitory B (28,250 sq feet)

Cost of CP system installed: $1,2 million ($42/sq ft)

Leakage rate at 50 Pa = 0.163 cfm/sq ft

New Construction, Dormitory C (61,500 sq feet)

Cost of CP system installed: $2.0 million ($32/sq ft)

Leakage rate at 50 Pa = 0.17 to 0.2 cfm/sq ft

What we have, what we need

What we have today:

High-level protection at high cost, or

Low-level protection at low cost

What we need:

High-level protection at low cost

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What we need

- *High-efficiency filter systems with low initial, operating, and maintenance costs; the capability to filter all threat agents.*

- *Reconfiguration of buildings' systems -- fans, filters, and barriers -- for economical pressurization.*

The challenge in collective protection for homeland defense

To develop systems that yield high levels of protection in buildings at affordable cost

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